Agronomy 406
World Climates

February 8, 2018

El Niño – Southern Oscillation (ENSO)

Review:

- Online textbook: 5.2.1 El Niño-Southern Oscillation
- El Niño, La Niña, and ENSO FAQ
- John Nielsen-Gammon article on relation of global temperature trends and ENSO

For Tuesday:

- METED Module: Understanding the Hydrologic Cycle

Next week:
METED module, Understanding the hydrologic cycle

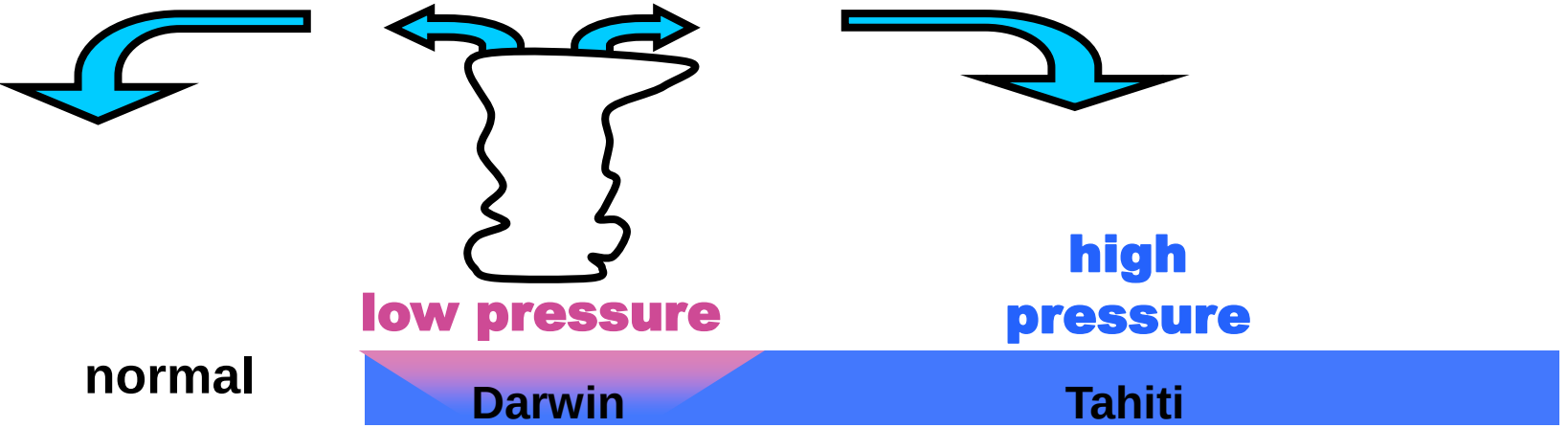
Linked from course schedule. The module includes reading and a quiz.

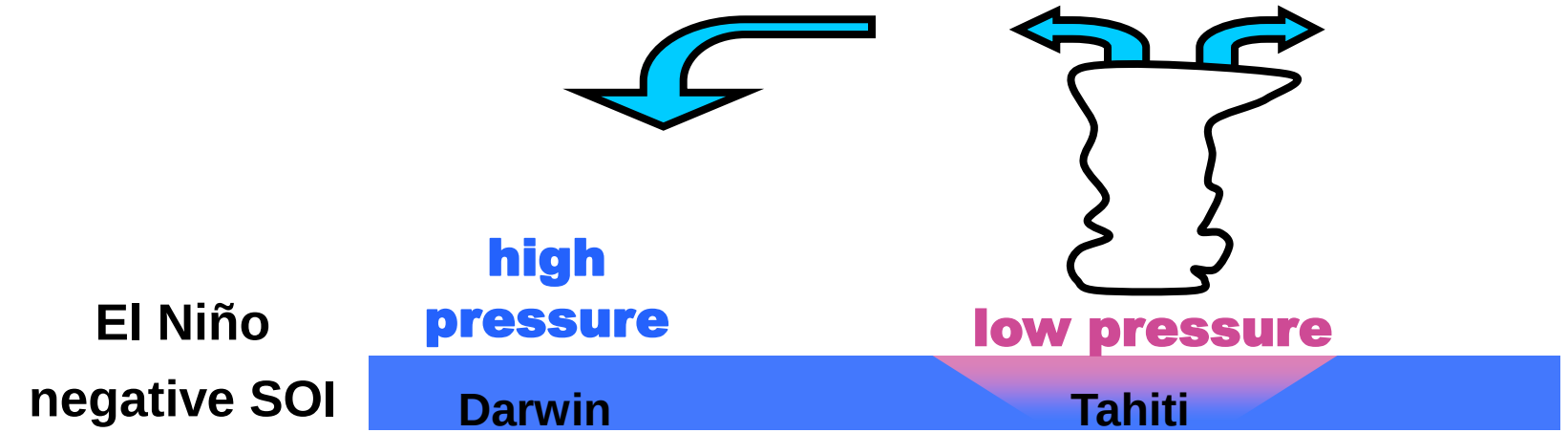
Take the quiz at the end of the module and send your score report (not the completion certificate) to agron406@gmail.com by **11:59 pm, Monday, Feb 12.**

Late quizzes will not be accepted.

Counts as two assignments, for both points and drops.

Shifts of low and high pressure with ENSO cause shifts of rainfall





Surface pressure anomalies change the Walker circulation

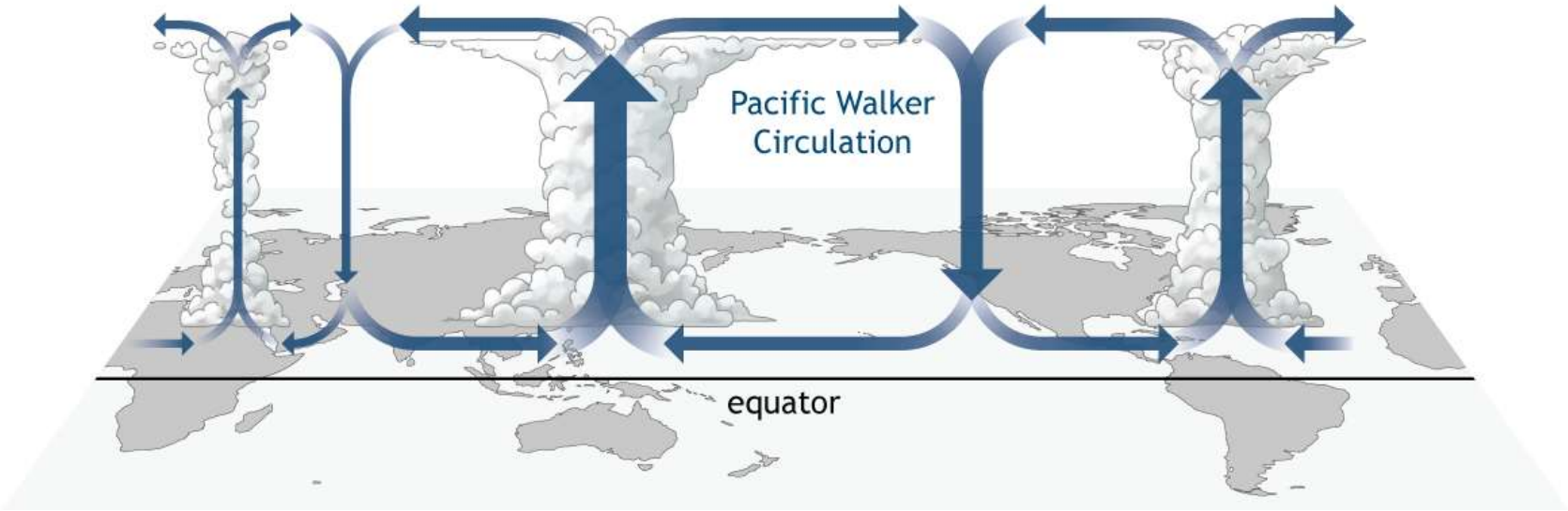
Changes in location of warm and cold water change the location and intensity of high and low pressure centers.

High and low pressure are associated with sinking motion (high pressure) or rising motion (low pressure).

> **Air that rises in one place must sink somewhere else** and vice versa.

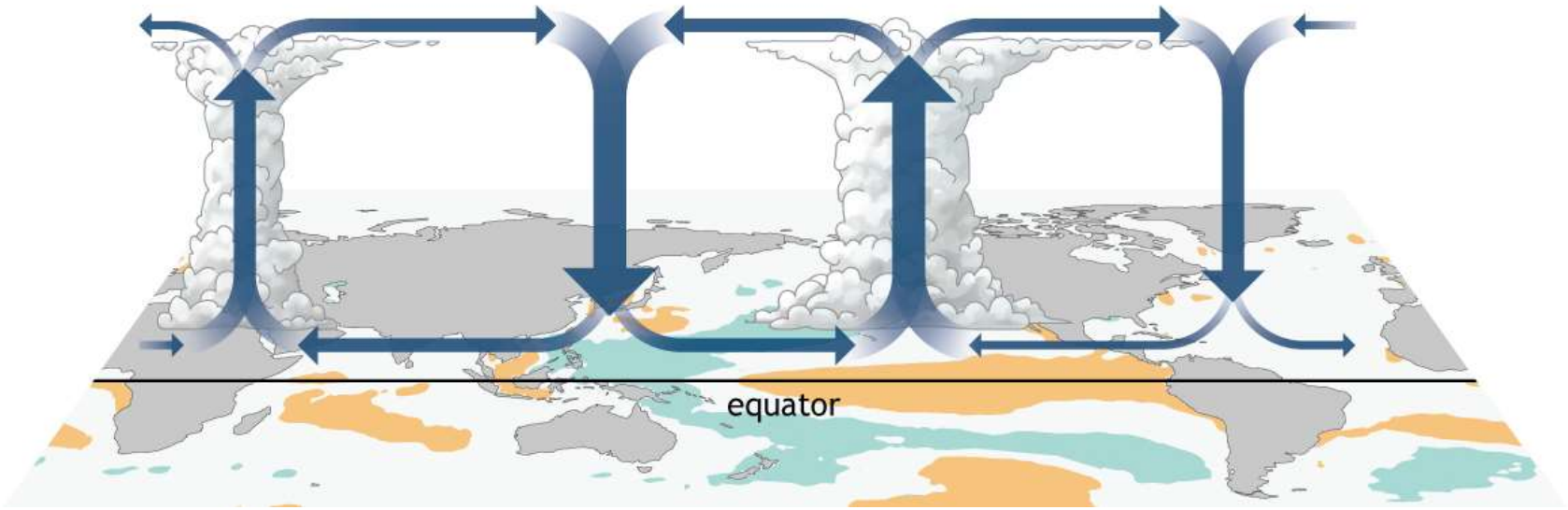
This produces **teleconnections** to other parts of the world. An example is the **Walker circulation,** an east-west circulation cell along the equator.

Usual Walker circulation



https://www.climate.gov/news-features/blogs/enso/walker-circulation-ensos-atmospheric-buddy

Anomalous Walker circulation during El Niño



Colors indicate sea surface temperature anomalies

Discuss: In what locations do you expect it to be wetter or drier than usual during El Niño?

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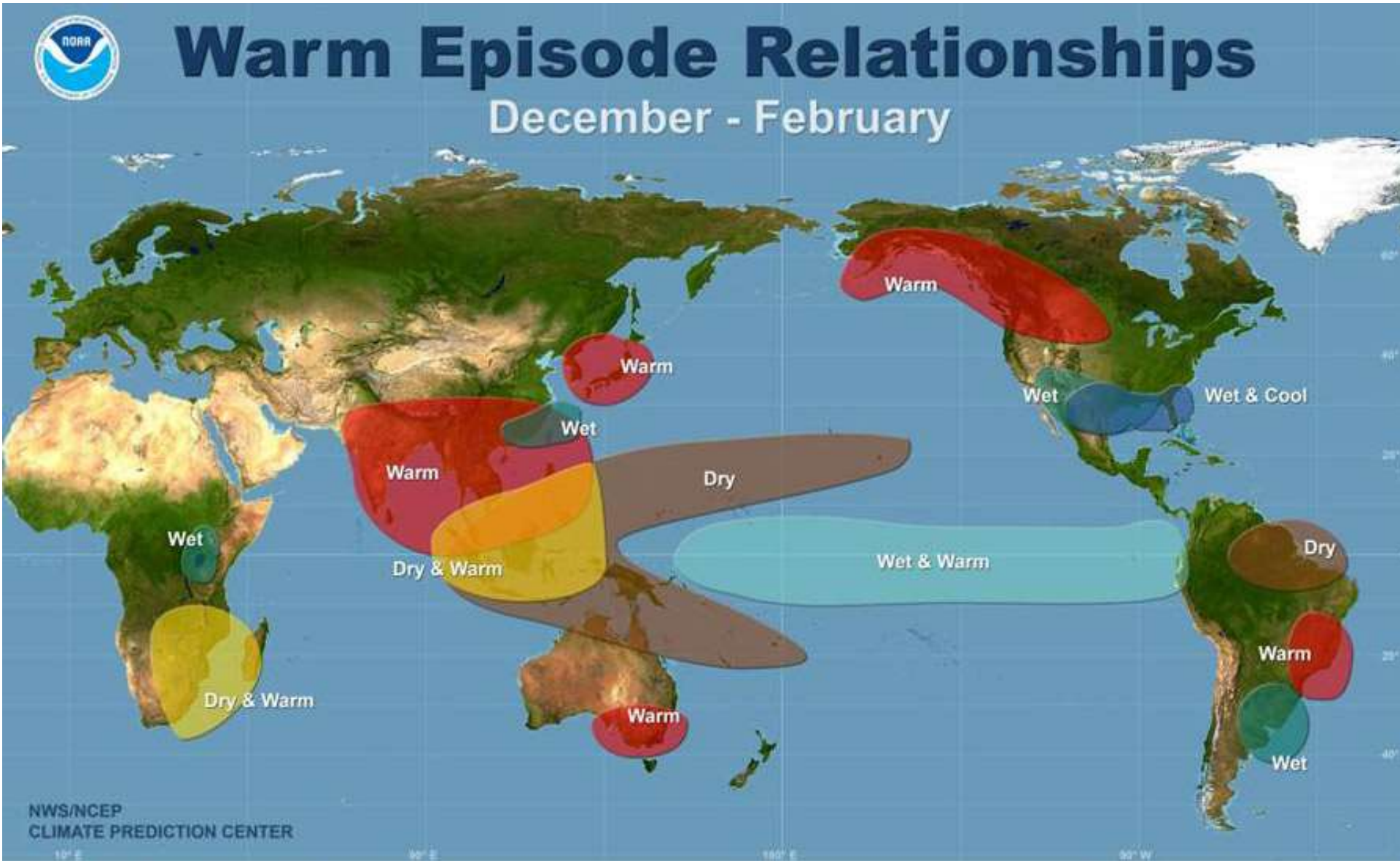
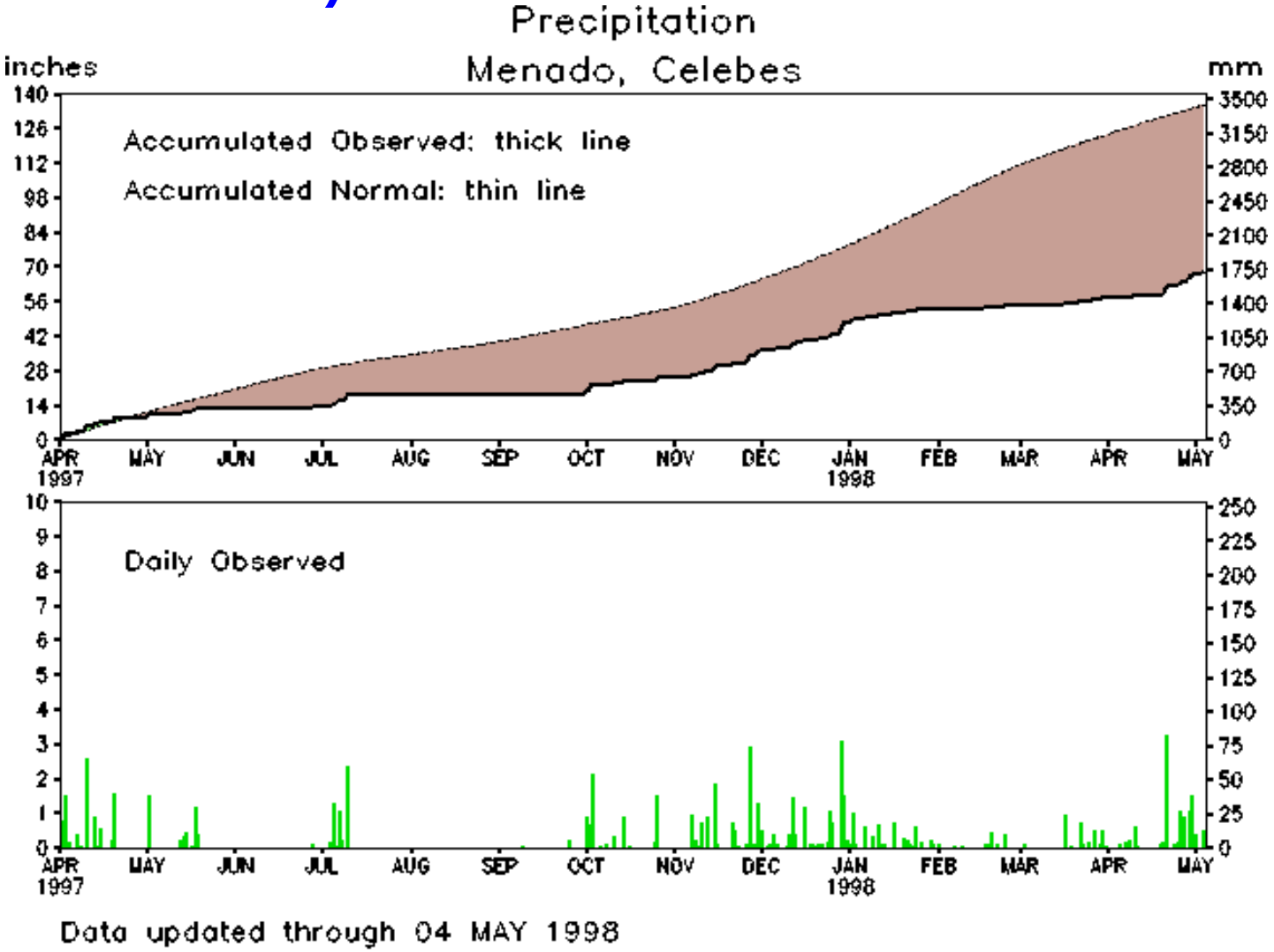
Global effects of El Niño (Dec-Jan-Feb)



Precipitation at Manado, Celebes (Indonesia) during a strong El Niño

(Where is this?)



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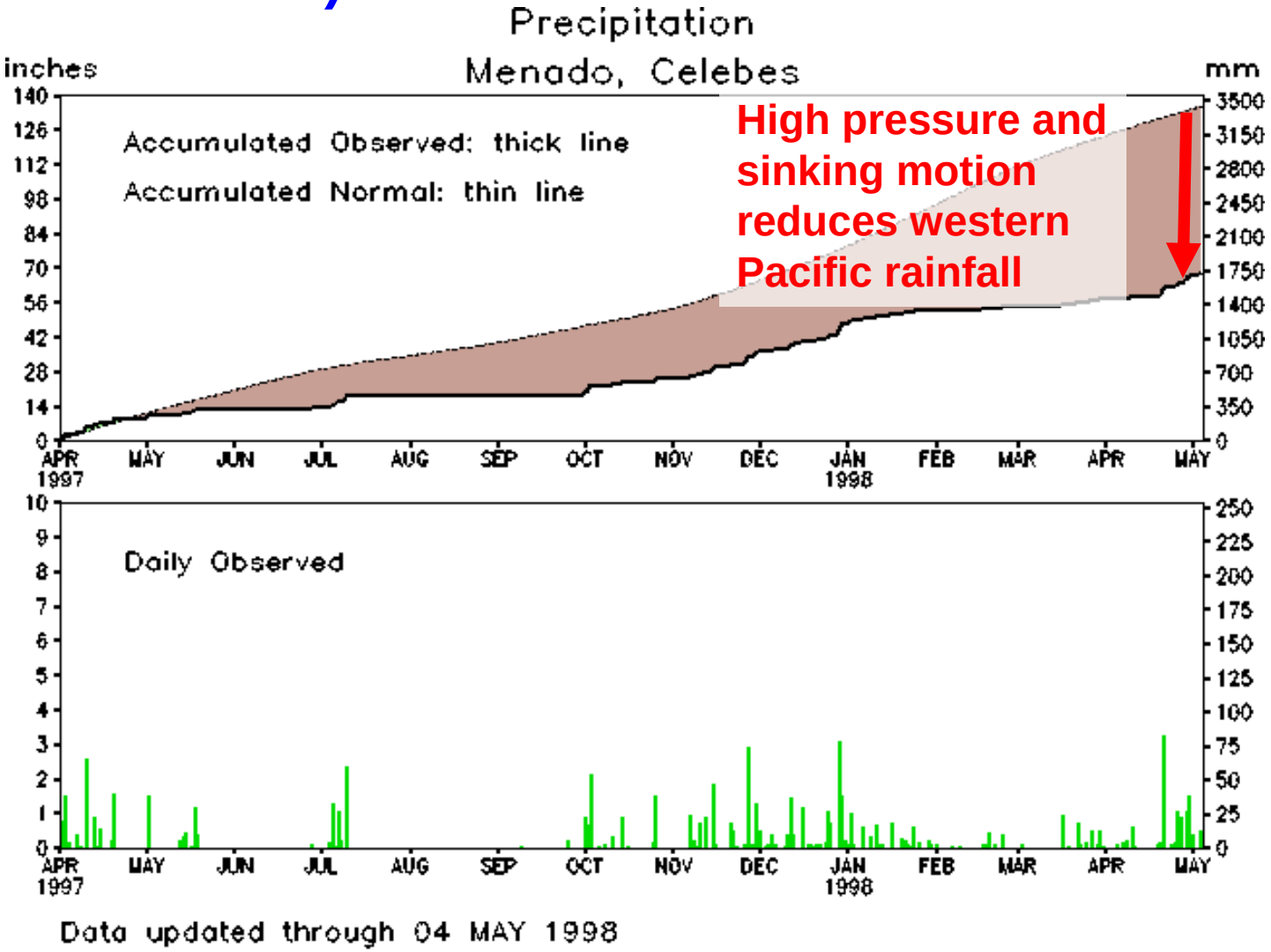

Precipitation at Talara, Peru during a strong El Niño

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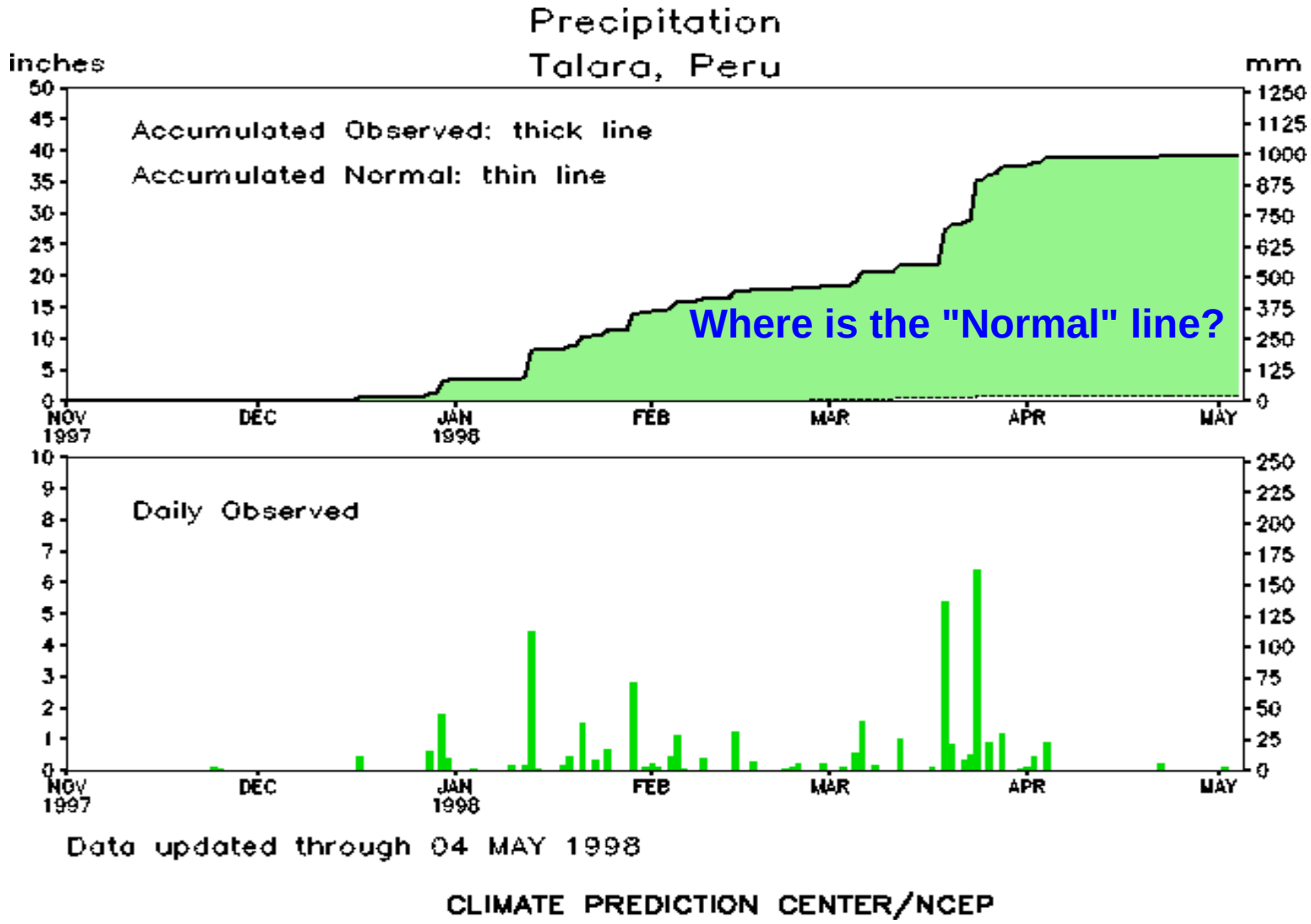

Precipitation at Talara, Peru during a strong El Niño

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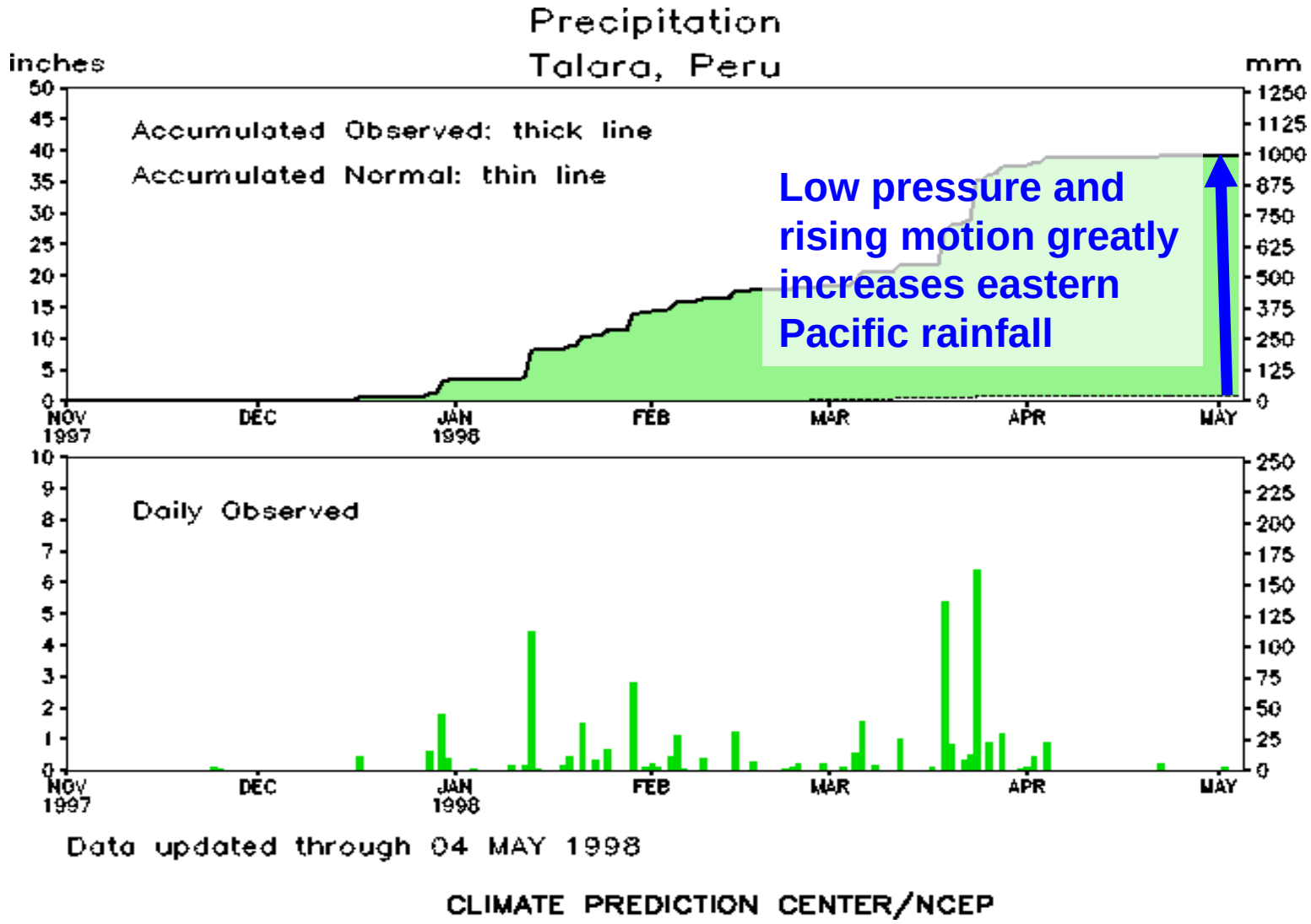
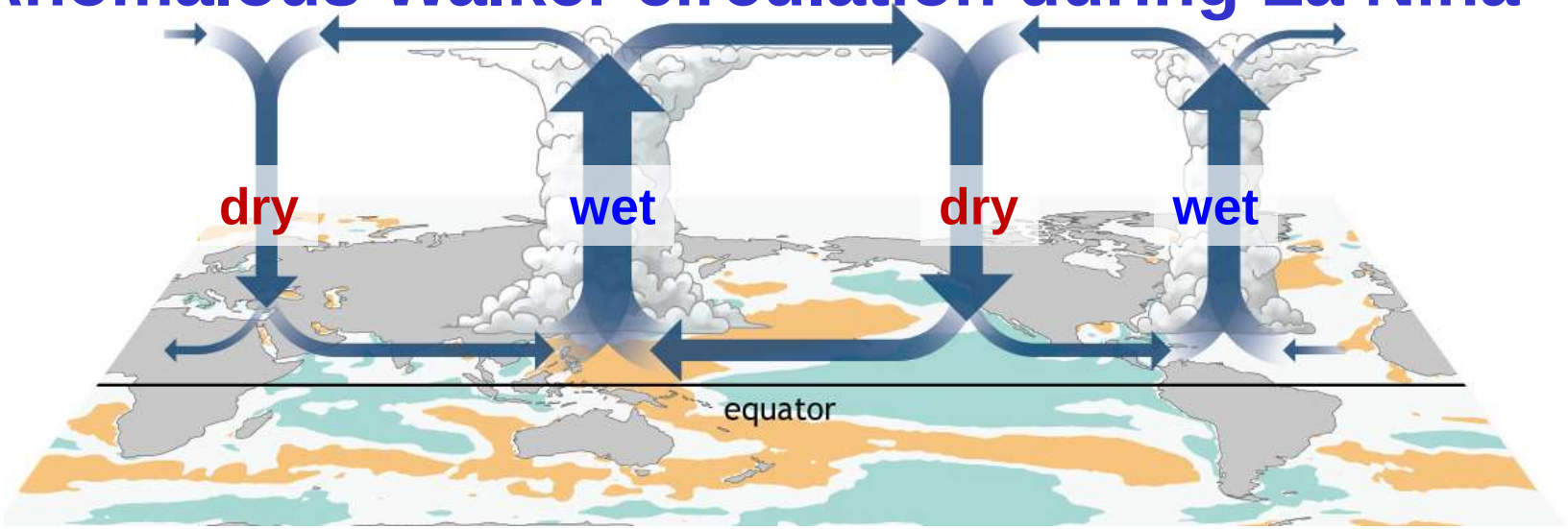


Anomalous Walker circulation during La Niña



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Discuss: In what locations do you expect it to be wetter or drier than usual during La Niña?

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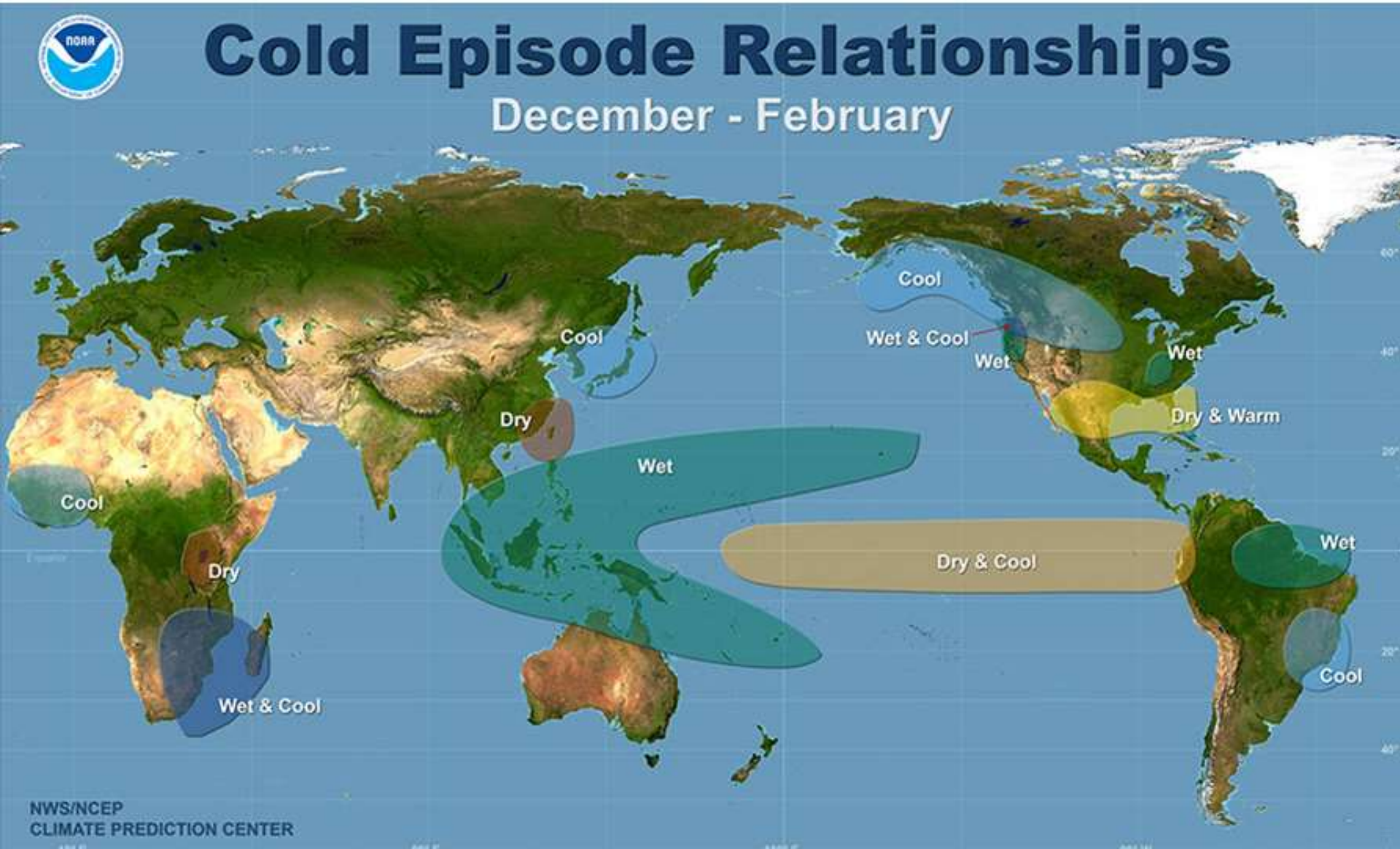


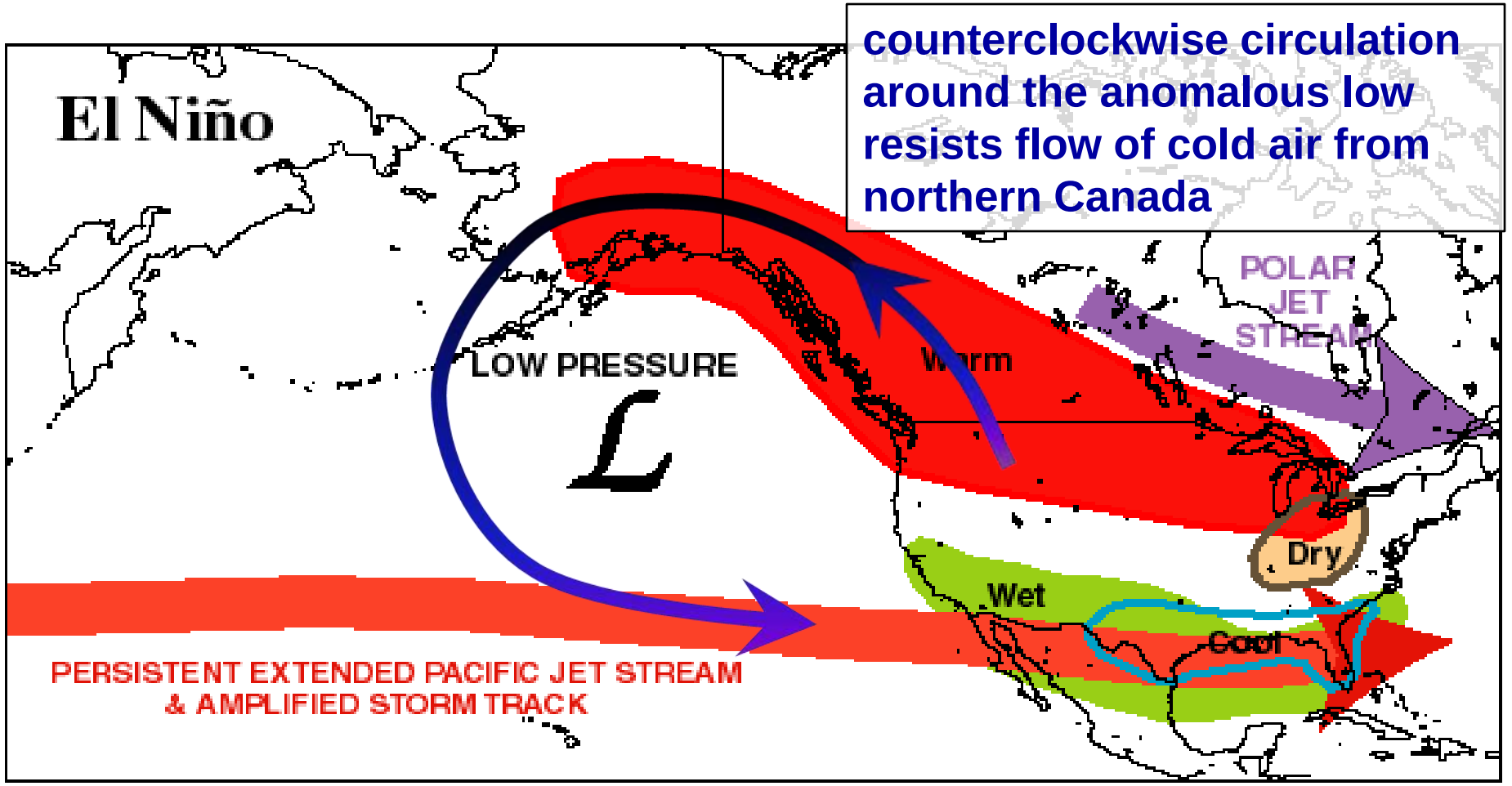
ENSO influences on North America

El Niño affects North America in large part by causing a **low pressure anomaly over the northeast Pacific:**

Circulation around the anomalous low strengthens the storm track over the southern U.S., producing cool and wet conditions.

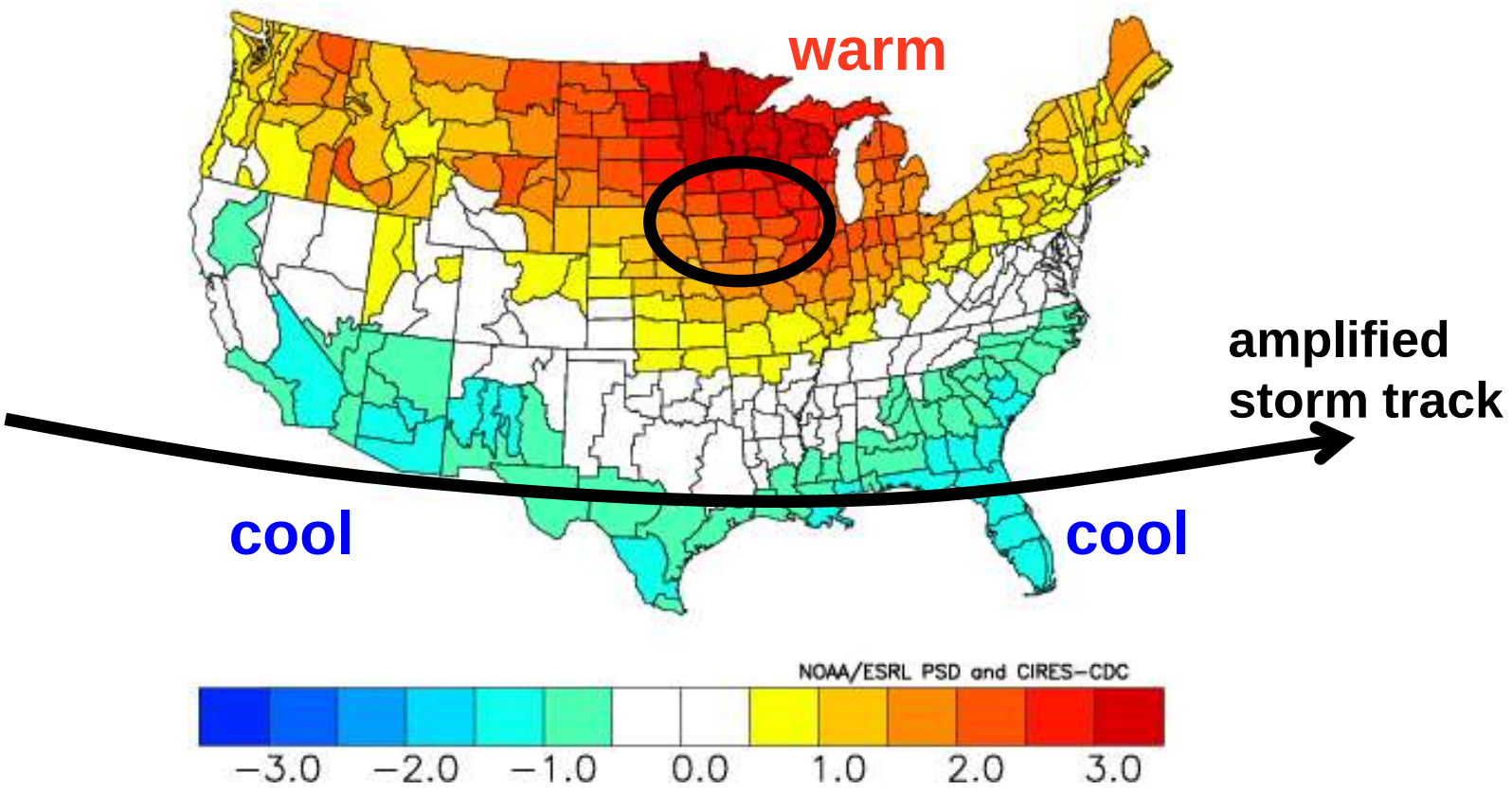
This circulation also tends to make western Canada and the central U.S. warmer, by reducing the tendency for cold air outbreaks.

Typical weather and circulation anomalies over North America in a moderate to strong El Niño



Average winter temperature anomalies during an El Niño event

Composite temperature anomalies (°F) compared to 1971-2000 average, December-March



http://www.srh.noaa.gov/tbw/?n=tampabayelninopage

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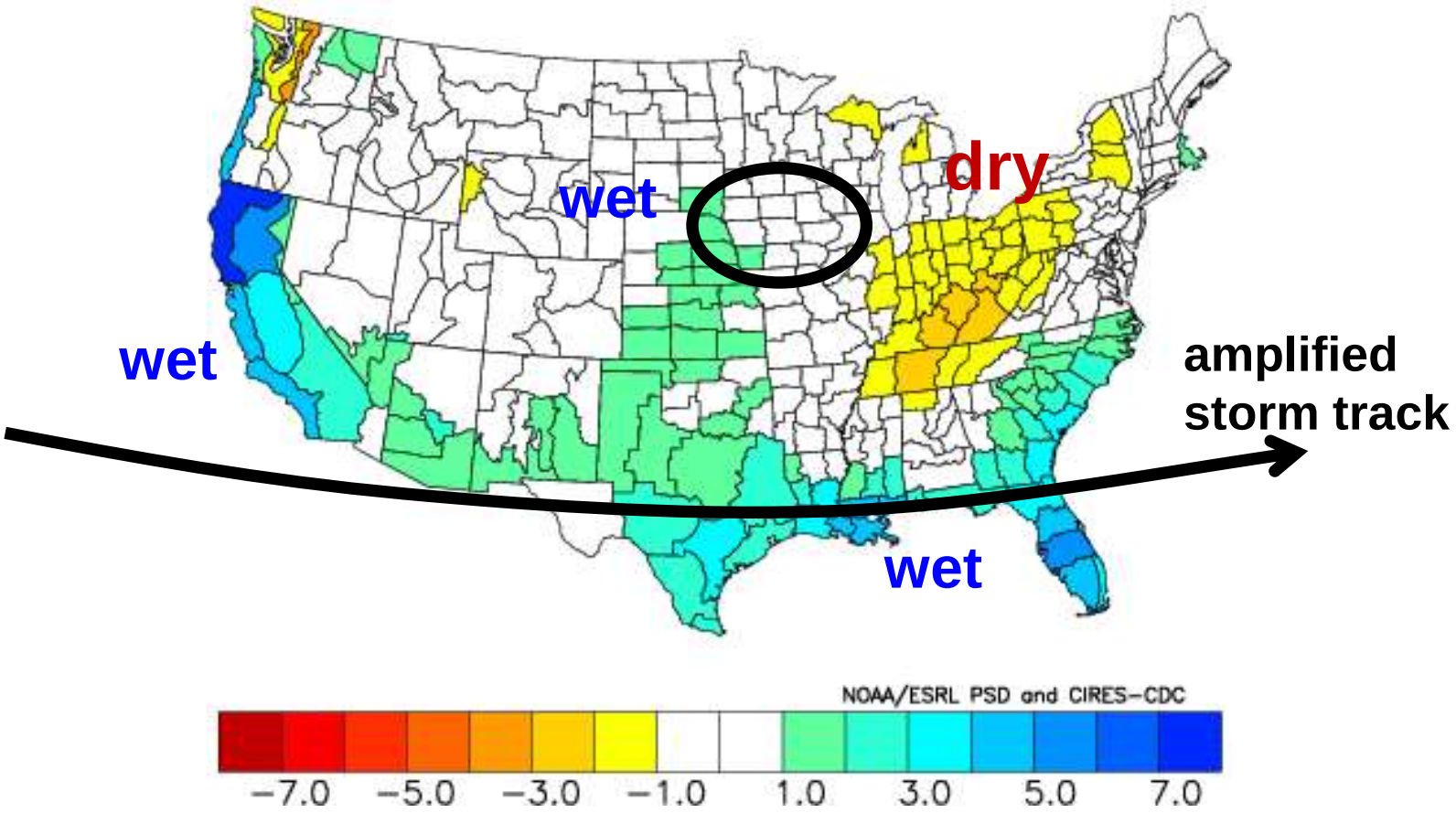

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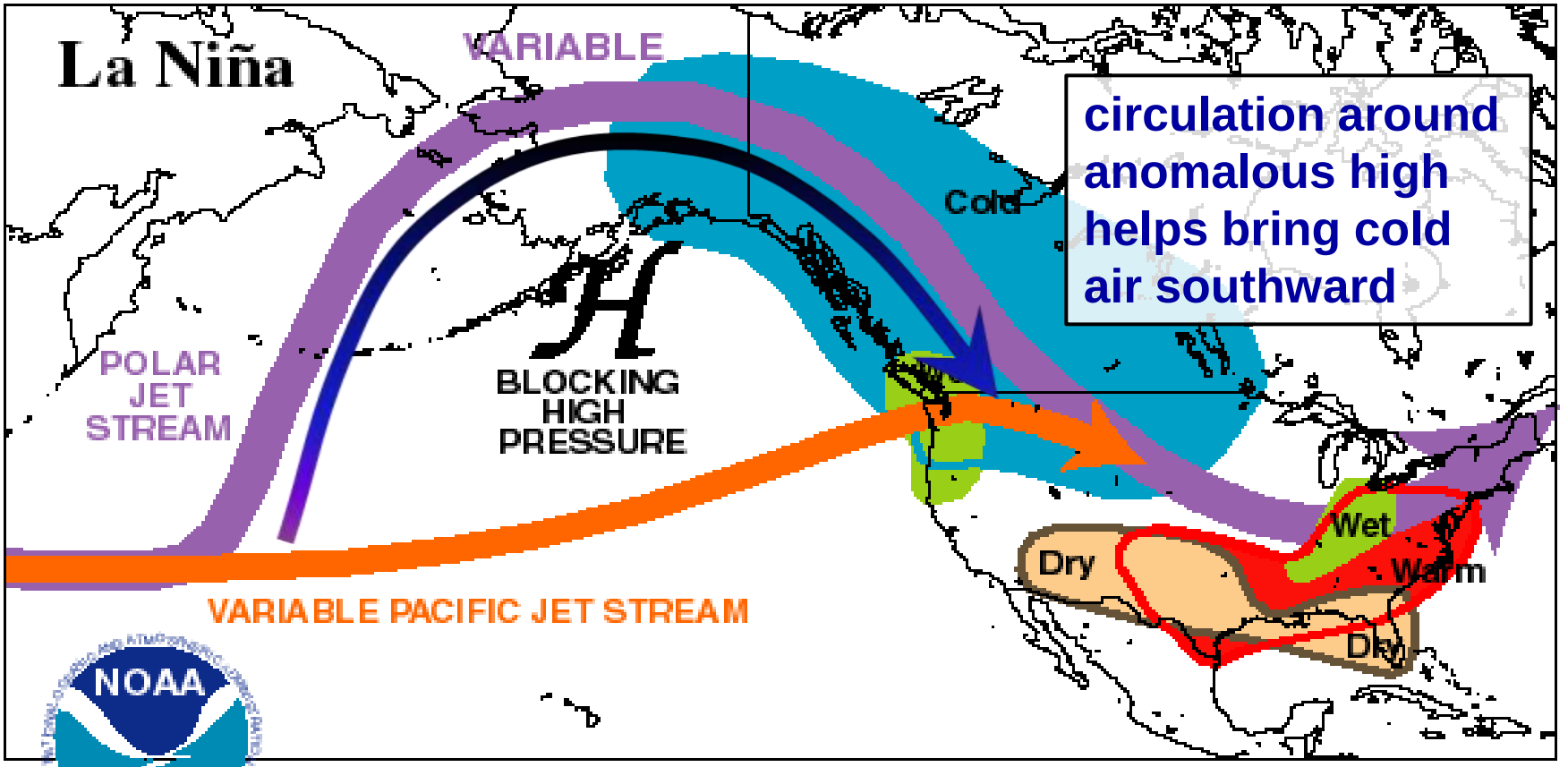

Climate Prediction Center/NCEP/NWS

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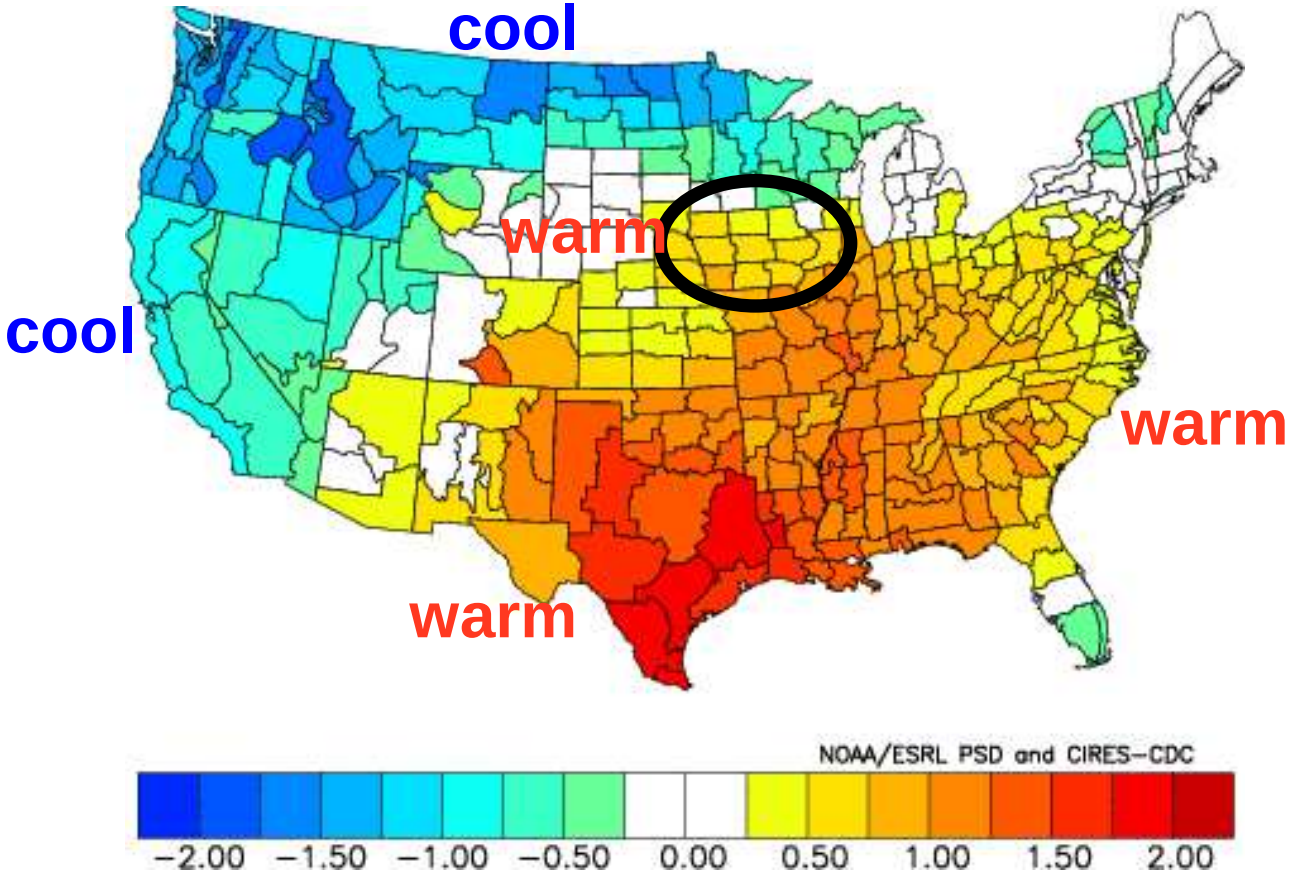

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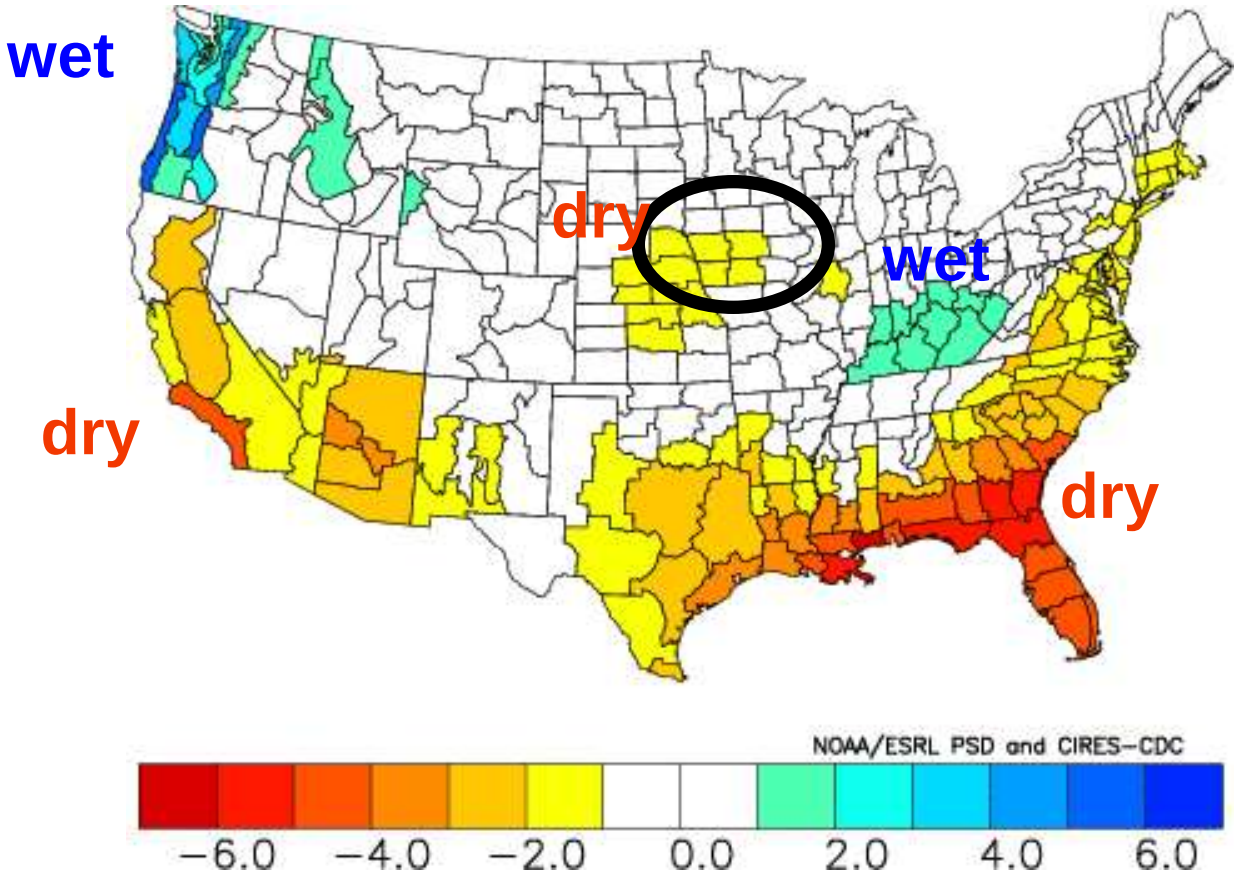

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Effects of ENSO on Iowa agriculture

We saw that **El Niño** tends to cause Iowa to be **warmer with near-normal precipitation.**

What do you think would be the effect on Iowa agriculture? (Odd numbered teams.)

We saw that **La Niña** tends to cause Iowa to be **warmer and slightly drier** than normal.

What do you think would be the effect on Iowa agriculture? (Even numbered teams.)

ENSO effects on agriculture in the north-central U.S.

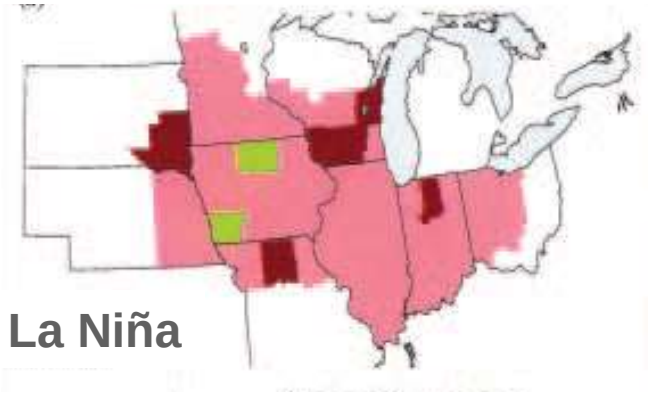
Wannebo and Rosenzweig (2003) studied effect of ENSO on north-central U.S. agriculture.

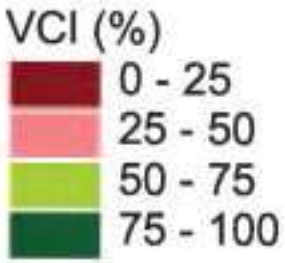
- Used a **Vegetation Condition Index** based on satellite measurements.

They found strong effects of La Niña on the region.

Effects of El Niño were too variable to derive a "typical" El Niño influence.

ENSO effects on agriculture in the north-central U.S.





El Niño vegetation condition index is not clearly different from neutral.

La Niña causes lower vegetation condition index.

Wannebo and Rosenzweig (2003)

ENSO: Current status

Strong El Niño conditions occurred from mid-2015 through early 2016.

One of the three strongest El Niño events in the historical record (along with 1982-83 and 1997-98).

Weak to moderate La Niña conditions were in place from the last half of 2017 through now.

Forecast is for La Niña to continue through the winter, then a transition to ENSO-neutral conditions in spring.

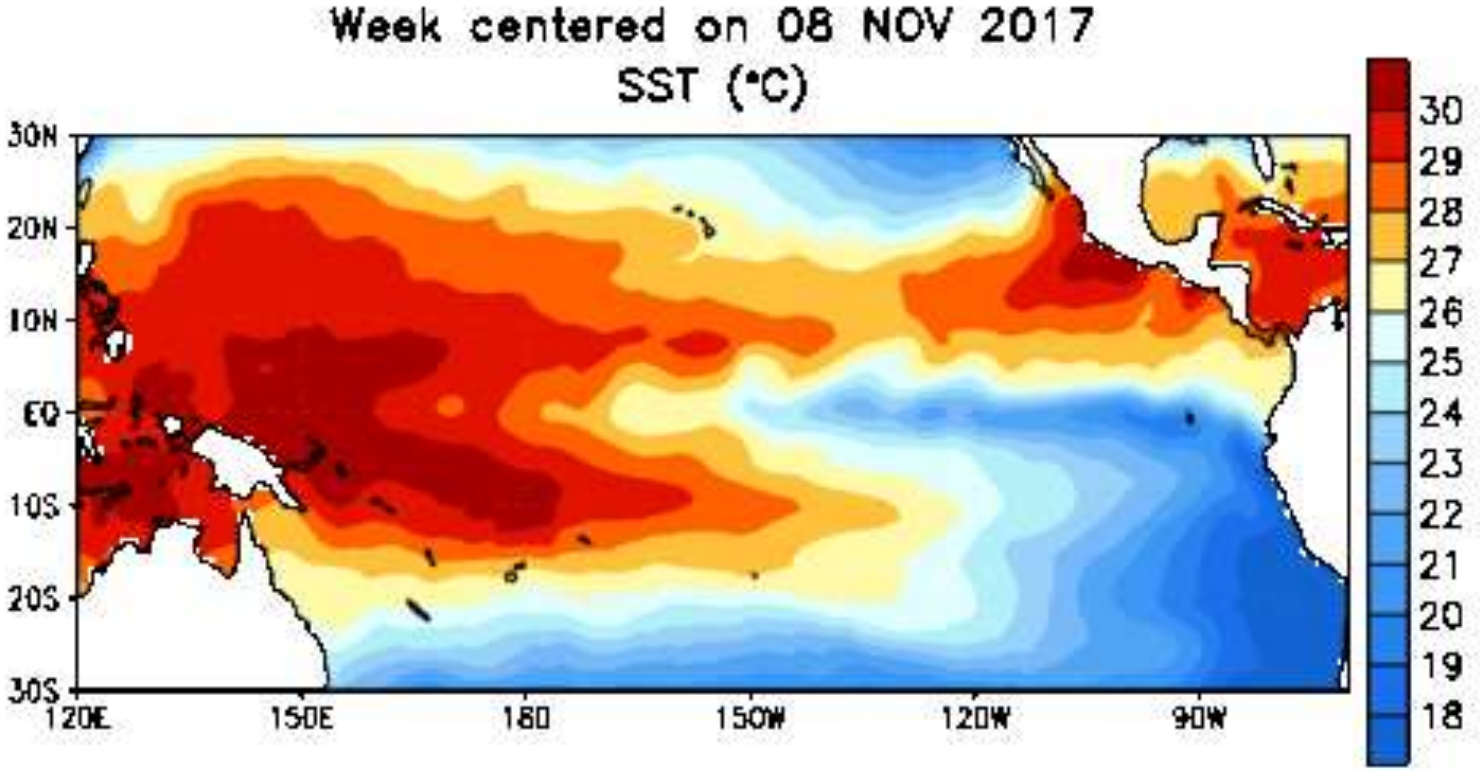
A good source for current data:

http://www.esrl.noaa.gov/psd/map/

Forecasts and discussions are available at:

http://www.esrl.noaa.gov/psd/enso/enso.forecast.html

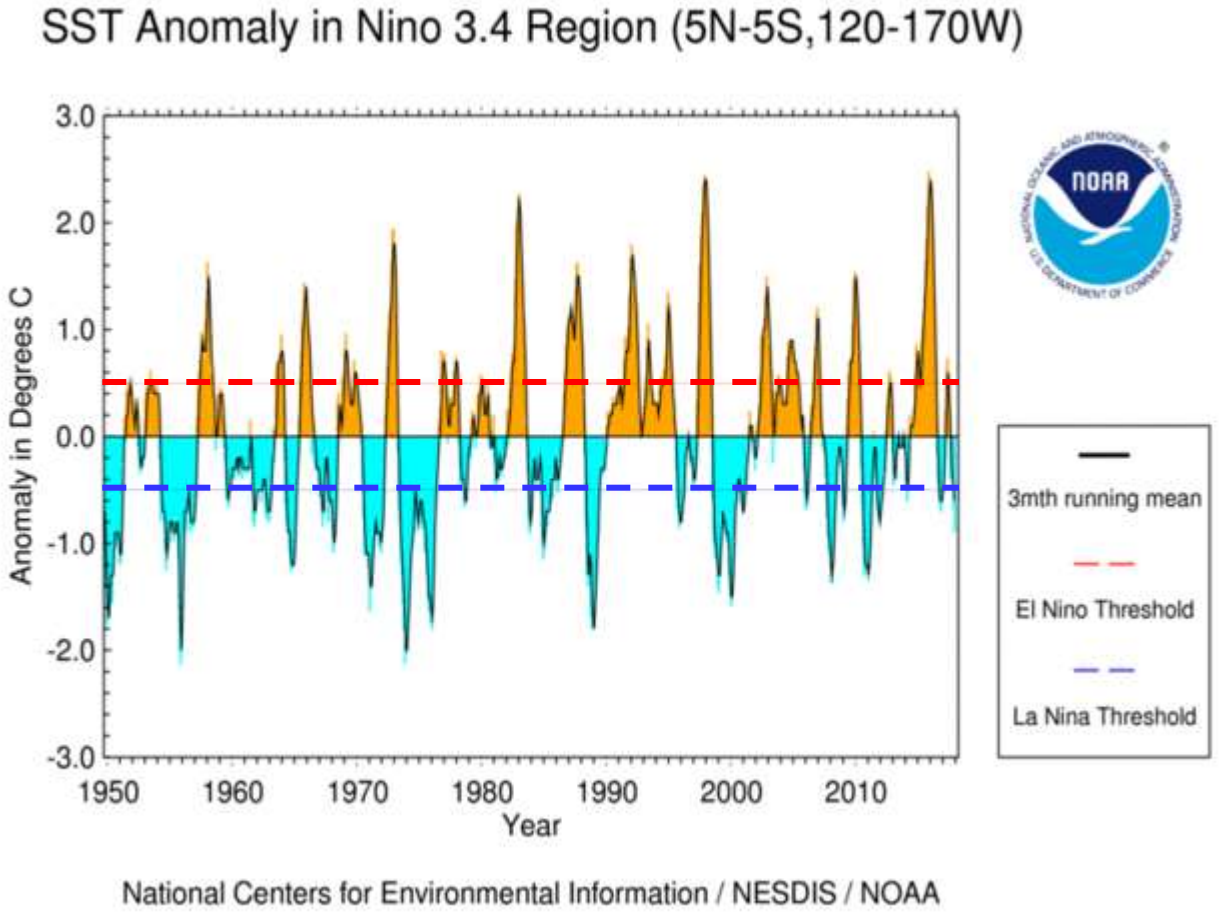
Animation of sea surface temperature anomalies for the past three months



http://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/enso.shtml

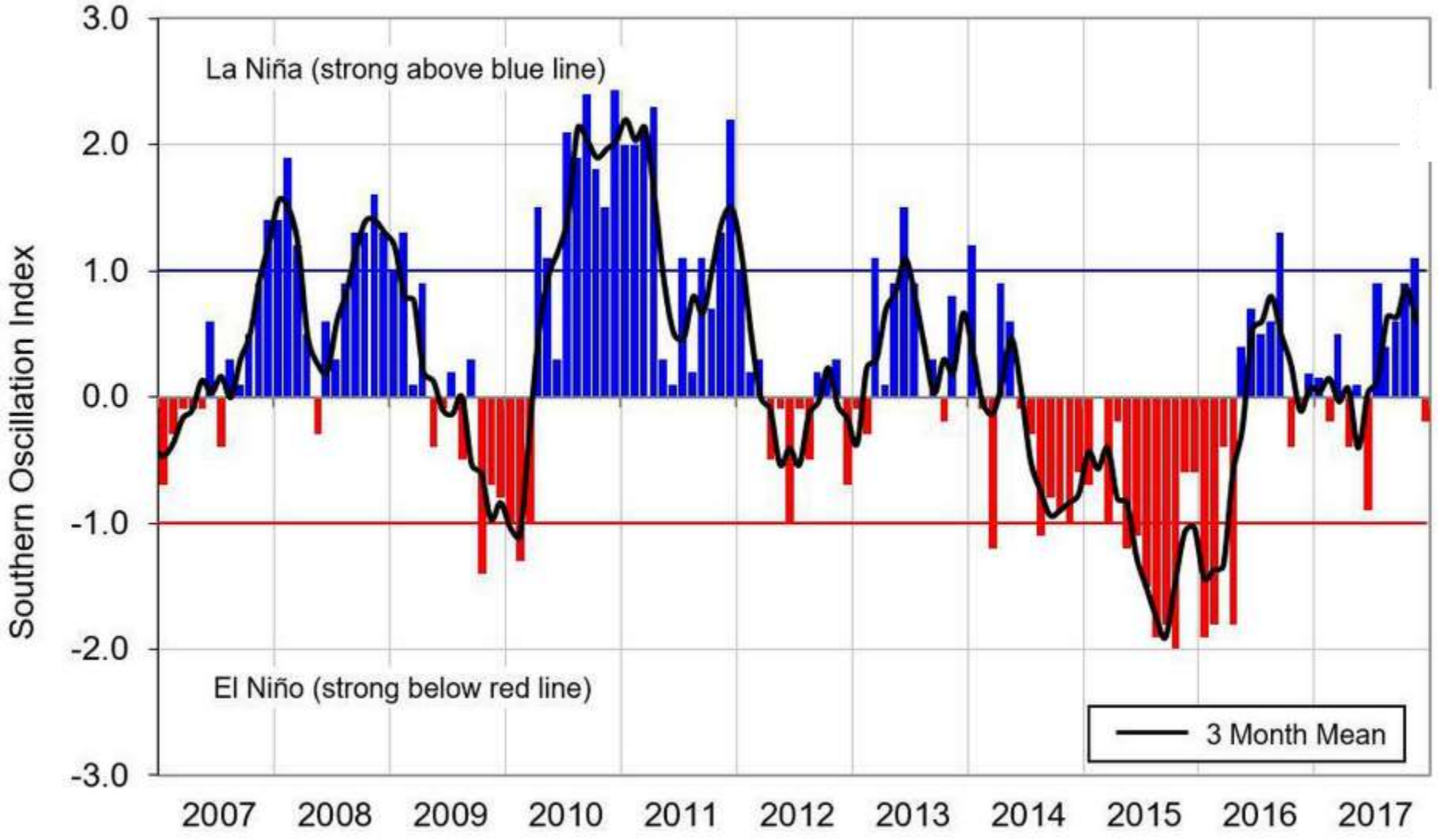
Historical NINO3.4 sea surface temperature anomaly, 1950-present

Notice the cycle is very irregular. There sometimes are back-to-back El Niño or La Niña events.



https://www.ncdc.noaa.gov/teleconnections/enso/indicators/sst.php

Recent values of SOI



https://www.niwa.co.nz/climate/nzcu/

El Niño and climate change

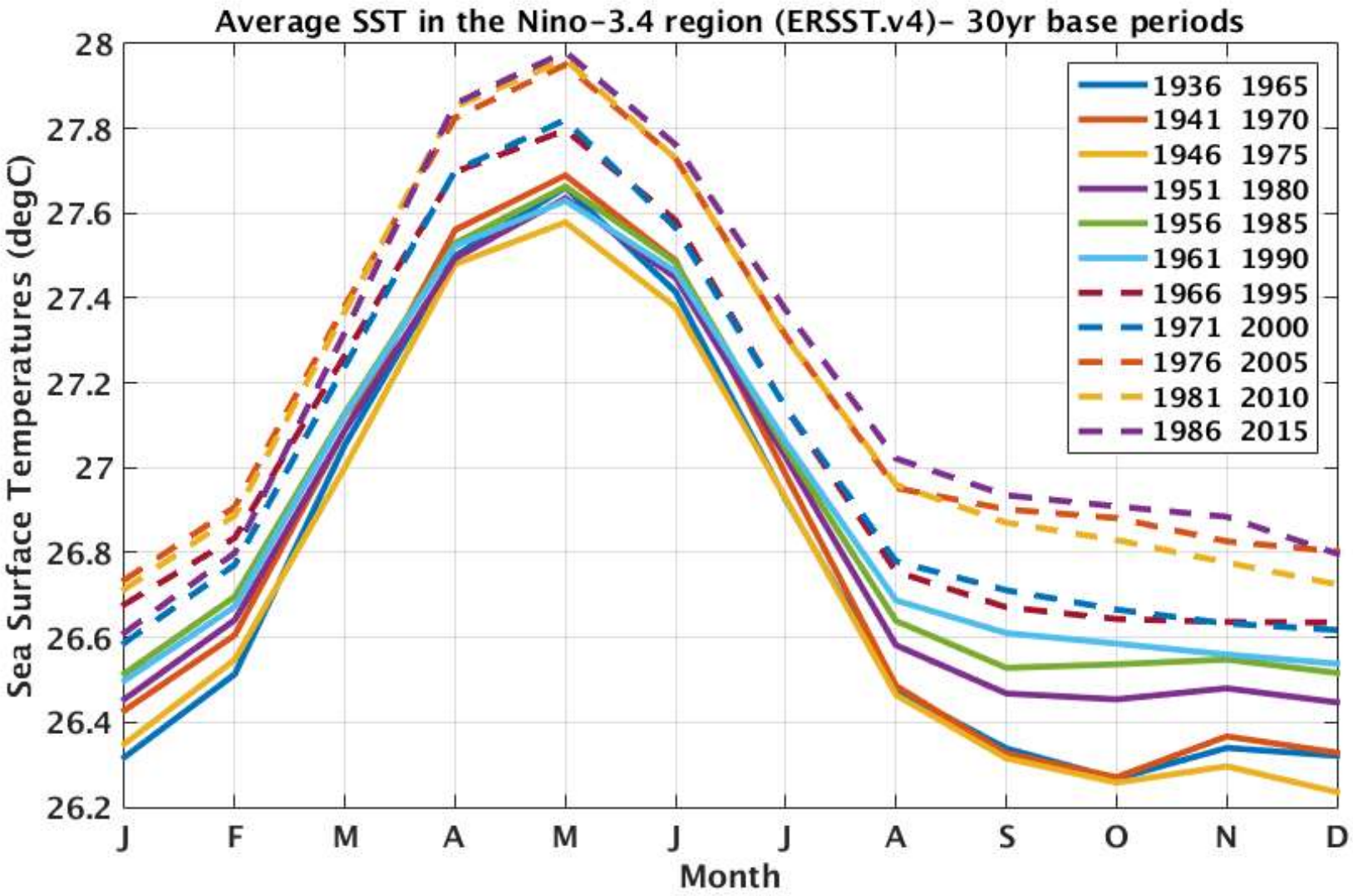
Recall the NOAA definition of El Niño:

- "El Niño is a phenomenon in the equatorial Pacific Ocean characterized by a five consecutive 3-month running mean of sea surface temperature (SST) anomalies in the Niño 3.4 region that is above the threshold of +0.5°C."

An anomaly is a **deviation from average.**

Because of climate change, **average SST is increasing.** NOAA has recently adopted rolling 30-year averages for defining average SST. These averages are updated every 5 years.

Moving 30-year base periods



from http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/ensostuff/ONI_change.shtml

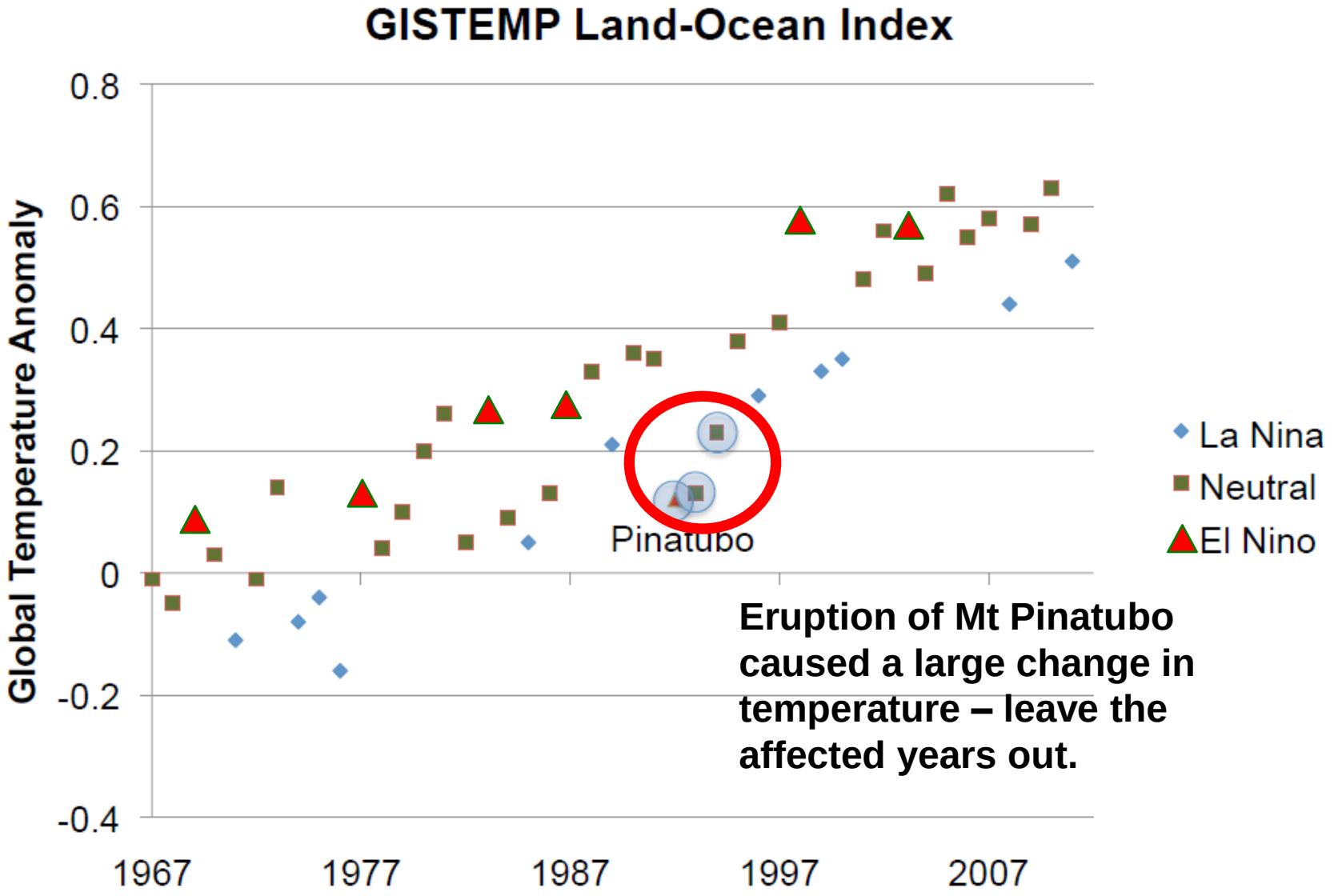
ENSO and climate change detection

El Niño and La Niña have effects around the world and thus can make global average temperature fluctuate.

Temperature change due to global warming is a few degrees over a century – around 0.02-0.03 ^{o}C per year. Temperature fluctuations due to ENSO can temporarily hide this gradual change.

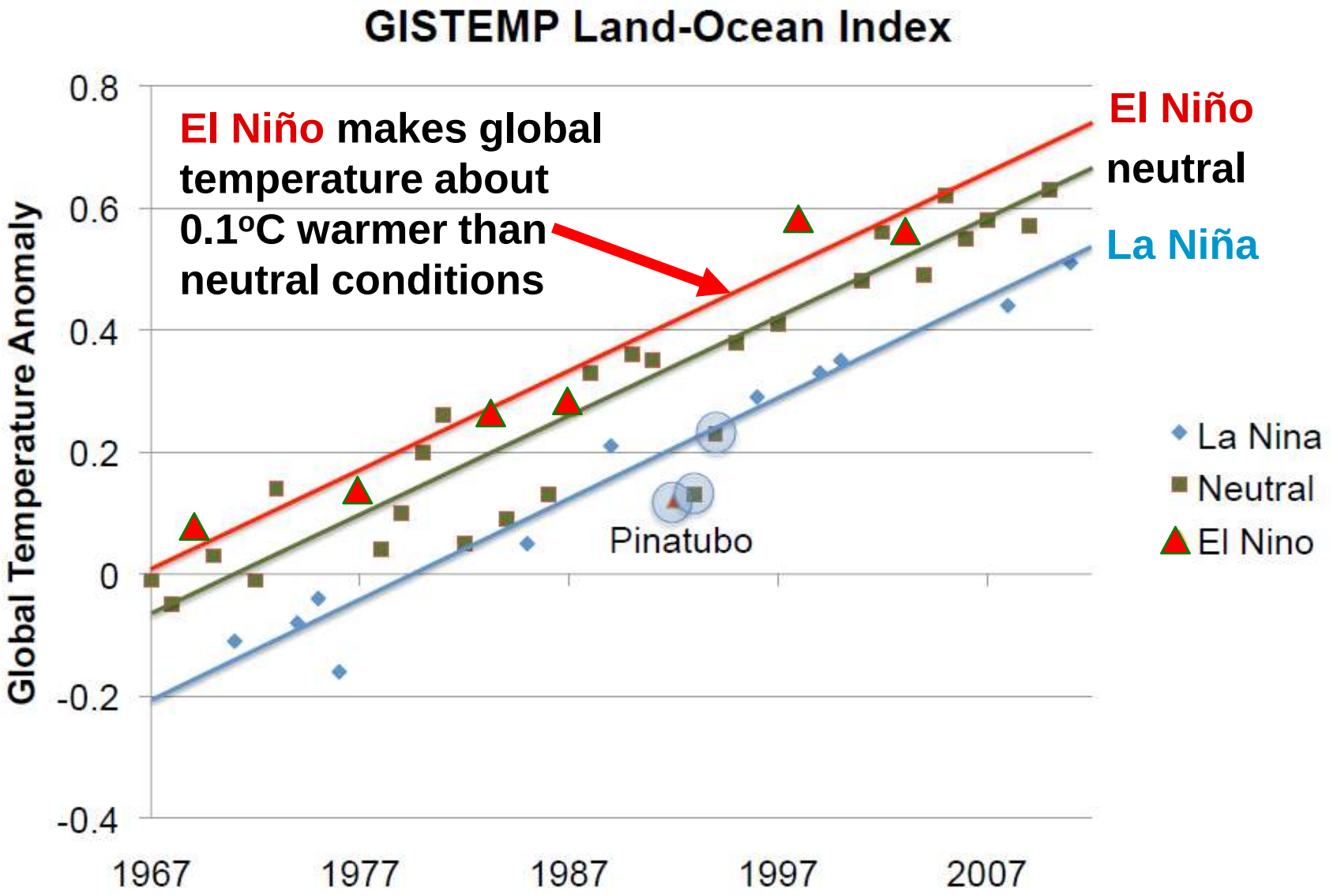
The article by John Nielsen-Gammon explains a way to separate the global warming signal from fluctuations due to ENSO.

Global temperature anomalies since 1967, distinguished by ENSO phase



Eruption of Mt Pinatubo caused a large change in temperature – leave the affected years out.

Fit separate lines to El Niño, La Niña and neutral years



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